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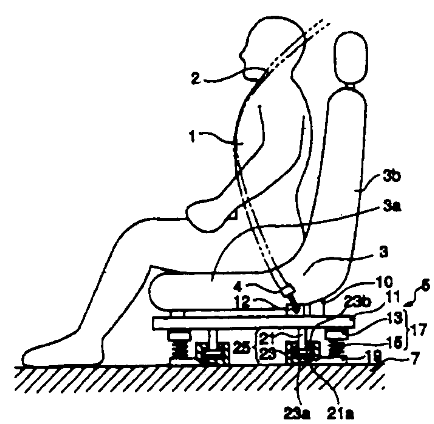
(54) **A seat weight measuring apparatus**

(57) To provide a seat weight measuring apparatus capable of improving the safety against an abnormal force acting on the seat.

A seat weight measuring apparatus (5) comprises seat connecting mechanisms (17) arranged between seat fixing portions (19) of a vehicle and a seat (3), and load sensors (13) which detect the seat weight loaded on the mechanisms. It further comprises a displacement restriction mechanisms (25) which restrict the displacement of the seat (3) relative to the seat fixing portions (19). When the load sensors receive a force exceeding a predetermined level, the excess load is born by the displacement restriction mechanisms instead of the load sensors.

Strain gauge

Fig. 1



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Description

[0001] The present invention relates to an apparatus for measuring the weight of a vehicle seat including the weight of a passenger sitting thereon, and more particularly to a seat weight measuring apparatus capable of increasing the safety against an abnormal force acting on the seat, or of alleviating a strength requirement for load sensors. The present invention also relates to a seat weight measuring apparatus having advantages in that the dimensional precision requirements for component parts or installing portions of the apparatus are about the same as the current level for other parts around the seat, or in that an overall thickness of the apparatus can be decreased.

[0002] Automobiles are equipped with seat belts and airbags to secure safety for passengers. In recent years, there is a trend for controlling the operation of such safety devices according to the weight of a passenger for improved performance of seat belts and airbags. For example, the amount of gas to be introduced into the airbag, an airbag inflating speed, or a pre-tension of the seat belt may be adjusted according to the weight of a passenger. For that purpose, some means are needed for measuring the weight of a passenger sitting on the seat. An example of such means includes a proposal (Japanese Patent Application No. 9-156666 filed by the applicant of this invention) which involves arranging load sensors (load cells) at four corners of the seat under seat rails and summing vertical loads acting on the load cells to measure the seat weight including the weight of the passenger.

[0003] The load sensors of the seat weight measuring apparatus described above are preferably of a small-sized type with a measuring capacity of up to 50 kg. Such load sensors may include: sensors having a strain gauge attached to (or formed on) a sensor plate that flexes when it is subjected to a load; piezoelectric type sensors; and capacitance type sensors which detect displacements of an elastic member that flexes upon receiving a load.

[0004] However, the deflection strokes of the load sensors described above are very small, and a very high dimensional precision of the members around the sensor is required for a normal functioning of the sensor. In addition, a special care should be taken dining the assembly, not to give an unbalanced displacement to a sensor at the assembly.

[0005] Meanwhile, from a strength viewpoint of the apparatus, fixing structures between seat connecting mechanisms and seat fixing portions are required to have a breaking load of 2300 kgf at a seat belt anchoring portion. If the load sensor itself is required to have this breaking load, the rigidity and strength of the sensor have to be very high, making it extremely expensive. In addition, the deflection stroke described above tends to become even smaller. Further, the size of the sensor may become too large to be installed between the seat connecting mechanisms and the seat fixing portions (seat brackets of the chassis).

[0006] An object of the present invention which is made in view of the above-described problems is to provide an apparatus for measuring the weight of a vehicle seat including the weight of a passenger sitting thereon, having advantages in that the dimensional precision requirements for component parts or fixing portions can be alleviated, or in that an overall thickness of the apparatus can be decreased. Another object of the present invention is to provide a seat weight measuring apparatus capable of decreasing processing cost and assembly cost A further object of the present invention is to provide a seat weight measuring apparatus capable of increasing the safety against an abnormal force acting on the scat, A still further object of the present invention is to provide a seat weight measuring apparatus capable of weight measurement with higher precision.

[0007] These objects are achieved with the features of the claims.

[0008] In order to solve the problems described above, the present invention provides an apparatus for measuring the weight of a vehicle seat including the weight of a passenger sitting thereon, characterized in that it comprises seat connecting mechanisms arranged between the scat and seat fixing portions of a vehicle, load sensors sensing the seat weight loaded on the seat connecting mechanisms, and displacement restriction mechanisms for restricting the displacement of the seat relative to the seat fixing portions caused by the deflections of said seat connecting mechanisms and/or load sensors in a predetermined range.

[0009] In the present invention, the displacement restriction mechanisms arranged between the seat and the seat fixing portions restrict the relative displacement between them in a certain range so that, when a force exceeding a predetermined level (for instance, exceeding a measurement range) acts on the load sensors, the excess load is born not by the load sensors but by the displacement restriction mechanisms (load restriction mechanisms). In this way, the safety is increased against an abnormal force acting on the load sensors, while the strength requirement for the load sensors can be alleviated.

[0010] Meanwhile, the object of what is referred to as the seat weight measuring apparatus in this specification is basically to measure the weight of a passenger on the seat. Therefore, an apparatus that measures only the weight of a passenger by canceling the weight of the seat itself is included in what is referred to as seat weight measuring apparatus in this specification.

[0011] In the present invention, it is preferable that the deflection strokes of said seat connecting mechanisms and/or said load sensors corresponding to the load variation within the measuring range or the loading range of the load sensors are set at 0.5-8 mm. In other words, the range of the displacement permitted by the displacement restriction mechanisms is preferably ±0.25-

4mm with respect to a normal state.

[0012] At this range of displacement stroke, current level of dimensional precision of the seat connecting mechanisms and seat brackets do not offer any problem in incorporation of the seat weight measuring apparatus between the seat and the seat fixing portions. From this view point it is more preferable that said deflection stroke is larger than 1 mm (±0.5 mm).

[0013] As a means to obtain the deflection stroke described above, deflection members can be incorporated in said seat connection mechanisms. By the action of the deflection members incorporated in the scat connection mechanisms, the deflection strokes of the seat connecting mechanisms within the measuring range can be amplified. As a result, the requirements of the dimensional precision or installation precision as to the members constituting the seat connecting mechanisms or the displacement restriction mechanisms can be alleviated.

[0014] The seat weight measuring apparatus according to an embodiment of the present invention is an apparatus for measuring the weight of a vehicle seat including the weight of a passenger sitting thereon, characterized in that it comprises seat connecting mechanisms arranged at four corners of the seat between the seat fixing portions and the seat rails, load sensors sensing the seat weight loaded on respective seat connecting mechanisms, and displacement restriction mechanisms restricting the displacement of the seat connecting mechanisms relative to the seat fixing portions in a certain range.

[0015] In the case that anchoring portions fixing anchors of a seat belt (buckle) are connected to the seat rails or seat, the displacement restriction mechanisms may be provided only at locations near the anchoring portions. Alternatively, the displacement restriction mechanisms may be provided at a plurality of locations including those near the anchoring portions, and only the displacement restriction mechanisms near the anchoring portions may be made robust enough to withstand the tensile force of the seat belt of some 2300 kg.

[0016] That is to say, a full load is born by the load sensors for locations with comparatively low breaking loads, and the deflection restriction mechanisms are installed only at the locations with the highest breaking loads. Alternatively, the deflection restriction mechanisms at the anchoring portions are particularly made robust. In this way, the overall weight of the seat weight measuring apparatus can be reduced.

[0017] A seat weight measuring apparatus according to another embodiment of the present invention is characterized in that each of load sensor sensing the seat weight loaded on respective seat connecting mechanisms is provided with a strain sensing member having a plurality of strain gauges which are arranged symmetrically relative to the central axis of said member, a bridge circuit consisting of said strain pages being constructed so that it does not output the twisting strain around said central axis of the member.

[0018] Otherwise, it is characterized in that slits are formed at sides of the region to which the strain gauges are attached.

[0019] With these constructions, weight measurements with high precision and linearity can be achieved.

[0020] An explanation will be made in the following with reference to the drawings.

Fig. 1 is a side view schematically showing the overall construction of a seat weight measuring apparatus according to an embodiment of the present invention.

Figs. 2(A), 2(B) show the construction of a seat weight measuring apparatus according to an embodiment of the present invention, in which Fig. 2(A) is a general sectional side view and Fig. 2(B) is a plan view of a sensor plate.

Fig. 3 is a sectional side view of a seat weight measuring apparatus according to another embodiment of the invention.

Fig. 4 is a sectional side view showing the construction of a seat weight measuring apparatus according to a further embodiment of the invention.

Figs. 5(A), 5(B) show a construction example of a seat weight measuring apparatus according to a further embodiment of the invention, in which Fig. 5(A) is a plan view of a sensor plate and Fig. 5(B) is a circuit diagram of a strain gauge circuit.

Figs. 6(A), 6(B) show the construction of a seat weight measuring apparatus according to a further embodiment of the present invention in which Fig. 6(A) is a general sectional side view and Fig. 6(B) is a plan view of a plate spring.

Figs. 7(A), 7(B) show the construction of a seat weight measuring apparatus according to a further embodiment of the present invention in which Fig. 7(A) is a general sectional side view and Fig. 7(B) is a plan view showing a sensor plate and plate spring.

Fig. 8 is a sectional side view showing a variation example of the seat weight measuring apparatus of Fig. 7.

Figs. 9(A), 9(B) show a seat weight measuring apparatus according to a further embodiment of the present invention having a cantilever construction, in which Fig. 9(A) is a sectional side view and Fig. 9(B) is a plan view of a plate spring.

Fig. 10 is a sectional side view showing a variation

example of the embodiment of Fig. 9.

Fig. 11 is a sectional side view showing a further variation example of the cantilever type scat weight measuring apparatus.

Figs. 12(A), 12(B) show an example of variation of the sensor plate, in which Fig. 12(A) is a plan view of a sensor plate and Fig. 12(B) is a circuit diagram of the strain gauges. Fig. 13 is a perspective view of another variation example of the sensor plate.

[0021] Through this specification, the words front, rear, left and right refer to front, rear, left and right as seen by a passenger 1, respectively.

[0022] Shown in Fig. 1 are a seat 3, a passenger 1 on the seat, and a seat weight measuring apparatus 5 installed below the seat. The seat 3 comprises a seat cushion 3a on which the passenger 1 is seated, and a seat back 3b for supporting the back of the passenger. Seat adjusters 10 project from the bottom of the seat cushion 3a at four locations, front and rear on both sides. While only two adjusters 10, front and rear on the left side, are shown in the figure, the right side adjusters 10 are hidden on the far side. Such an illustrative relation is also true for other portions to be described below. The seat adjusters 10 are portions of the seat frame that project from the seat 3, capable of sliding along seat rails 11 in the longitudinal direction when adjusted by the passenger 1.

[0023] The seat rails 11 are members which extend in the longitudinal direction of a vehicle body (chassis) 7 and have a grooved cross section (not shown) in which the lower end portions of the seat adjusters 10 slide. There are two seat rails 11, one on each lateral side, under the seat cushion 3a. In a conventional seat without seat weight measuring apparatus, the seat rails 11 are securely fixed by bolts to seat brackets of a chassis of a vehicle body. At a rear part of the seat rails 11, an anchoring portion 12 for fixing a buckle 4 of a seat belt 2 is provided. The anchoring portion 12 is loaded with a tension of a seat belt 2. The anchoring portion 12 has a breaking load of 2300 kgf taking into consideration of a case of a vehicle collision.

[0024] Under the seat rail 11, two scat weight measuring apparatus 5 are provided, one at front portion and one at rear portion of the seat rail. It should be noted that under the right side seat rail, there are also provided two seat weight measuring apparatus 5 which are not shown. Thus, the seat weight measuring apparatus 5 are provided at four locations, front and rear on both sides, below the seat 3.

[0025] Each of the seat measuring apparatus 5 comprises a seat connecting mechanism 17 and a displacement restriction mechanism 25, and is arranged between the seat rails 11 and the seat fixing portions 19. In this embodiment, each of the seat connecting mechanism 17 comprises a load sensor 13 and a deflection member 15, connected in series connection. The load sensor 13 is a strain gauge type or capacitance type sensor which detects the load received by the seat connecting mechanism 17. The deflection member 15 is a member for amplifying the displacement (movement) of the seat rail 11 upon loading of the passenger weight. The deflection member 15 can be constructed with spring, rubber, gas cushion and the like. Examples of specific constructions of the sensor 13 and the deflection member 15 will be described later.

[0026] In this embodiment, each of the displacement restriction mechanism 25 comprises a restriction bar 21 connected to the lower surface of the seat rail 11 and a restriction block 23 formed on the seat fixing portion 19. An end portion 21a of the restriction bar 21 is enlarged in diameter in a flange-like configuration. The restriction block 23 has a recess 23a inside thereof and a flange 23b, extending inward, formed at the upper end of the recess. The end portion 21a of the restriction bar is contained within the recess 23a of the restriction block, keeping a certain gap on all longitudinal and lateral surfaces.

[0027] When an abnormal load is applied on the seat rails 11, deforming the load sensor 13 and the deflection member 15 over a certain limit, the end portion 21a of the restriction bar of the displacement restriction mechanism 25 abuts against an internal wall of the recess 23a of the restriction block. For instance, when the passenger 1 moving forward during a vehicle collision is restrained by the seat belt 2, the seat belt 2 receives a tension force caused by the inertia force of the passenger 1. At this time, the restriction bar 21 is pulled upward but the movement is stopped when the end portion 21a of the restriction bar abuts against the lower surface of the flange 23b of the restriction block. Thus, when the load sensor receives a force exceeding a predetermined value (for instance, exceeding a measuring range), the excess load is born by the displacement restriction mechanism (load restriction mechanism), instead of the load sensor. As a result the breaking load requirement for the load sensor 13 can be very low, achieving the down-sizing and cost-reduction of the load sensor.

[0028] Hereinafter, the relation between the displacement restriction mechanism 25 and the deflection member 15 of the seat connecting mechanism 17 will be described. If the deflection member 15 is absent (if a rigid member is used), and deformation of load sensor 13 over the measuring range is in the order of 0.1 mm as described earlier, the gap between the end portion 21a of the restriction bar of the displacement restriction mechanism 25 and the recess 23a of the restriction block should also be in the order of 0.1 mm, because the end portion 21a of the restriction bar is required to abut against the internal surface of the recess 23a of the restriction block as soon as the load exceeds the measuring range, so that the excess load is born by the displacement restriction mechanism 25.

[0029] That is to say, the displacement restriction mechanism is required to have an operational precision in the order of 0.1 mm corresponding to the stroke of the load sensor, which in turn requiring the parts dimensional precision and assembly precision in the order of 0.01 mm. This cannot be fulfilled at all with current dimensional precision of the parts around the vehicle seat, which mainly consist of pressed products. In short, the small deflection stroke of the load sensor calls for a high dimensional precision in the displacement restriction mechanism and those members used around it. In this embodiment, the deflection stroke of the seat connecting mechanism in the measuring range or loading range of the load sensor is amplified by the action of the deflection member of the seat connecting mechanism. As a result, the dimensional precision and assembly precision requirements for members constituting the seat connecting mechanism and the displacement restriction mechanism can be alleviated.

[0030] Hereinafter, specific examples of the seat connecting mechanism and the displacement restriction mechanism will be described.

[0031] Figs. 2(A), 2(B) show the construction of a seat weight measuring apparatus according to an embodiment of the present invention, in which Fig. 2(A) is a general sectional side view and Fig. 2(B) is a plan view of a sensor plate.

[0032] Shown in the upper most portion of Fig. 2(A) is a seat rail 11. Under the seat rail 11, a sensor frame upper plate 51 and a sensor frame 53 are fixed by means of bolts 52. The sensor frame upper plate 51 is a robust plate having a hole 51a at the center. The sensor frame 53 has a saucer-like configuration with a recessed central portion. Formed at the upper external periphery of the frame 53 is a flange 53a which is fixed to the sensor frame upper plate 51 by means of the bolts 52, as described above. The bottom plate 53b of the sensor frame 53 is provided with a hole 53c formed at the center thereof.

[0033] A sensor plate 57, which is referred to in this specification as a detecting member, is fixed by means of bolts 55 to the lower surface of the sensor frame upper plate 51. The sensor plate 57 is made of a stainless steel and is a rectangular plate with a thickness of 3 mm, a width of 20 mm, and a length of 80 mm. As shown in Fig. 2(B), the sensor plate 57 is provided with a central shaft hole 57c formed in the central portion and with bolt holes 57a formed in the both side portions. Attached to the upper surface of the sensor plate 57 are strain gauges 57b, a pair of them being attached on each front and rear portions of the plate (left and right portions in Fig 2(B)). These strain gauges 57b are for measuring the load acting on the sensor plate 57, by detecting the strain of the plate 57. In addition, instead of detecting the strain of the sensor plate 57 by strain gauges 57b, the deflection of the sensor plate 57 can be detected by a capacitance type sensor or a Hall element, followed by conversion of the deflection to the strain.

[0034] Fitted into the hole 57c located at the center of the sensor plate 57 is a central shaft 59 and the sensor plate 57 and the central shaft 59 are fixed to each other by means of a nut 59a. Inserted in the holes 57a located at both sides of sensor plate 57 are bolts 55 upward, fixing the sensor plate 57 to the sensor frame upper plate 51.

[0035] The central shaft 59 is a cylindrical shaft having several steps and flanges and comprises those parts and portions as, from its upper side, the upper nut 59a, a flange 59b, a sensor frame penetrating portion 59c, a small diameter portion 59d, and a lower nut 59e. The upper nut 59a fixes the sensor plate 57 as described above, The nut 59a enters into the central hole 51a of the sensor frame upper plate 51. In the nominal state, the gaps between the nut 59a and the hole 51a are, for example, 0.25 mm in the longitudinal direction and 0.5 mm in the radial direction. When the seat rail 11 receives a large force and parts including the plate 57 are deformed in some extent, the nut 59a abuts against the internal surface of the hole 51a. At this point, the further deformation of the sensor plate 57 is stopped. That is, the nut 59a on the central shaft and the central hole 51a of the sensor upper frame constitute the displacement restriction mechanism of the present invention.

[0036] The outer diameter of the flange 59b of the central shaft 59 is greater than the diameter of the central hole 53c of the sensor frame 53, the lower surface of the flange 59b facing the upper surface of the sensor frame bottom plate 55b with a gap of 0.25 mm in the nominal state. When the seat rail 11 receives a force acting upward and the deformation of the sensor plate 57 advances, the sensor frame 53 is lifted and the central upper surface 53d of the frame bottom plate 53b abuts against the bottom surface of the central shaft flange 59b. Meanwhile, a gap of 0.7 mm exists between the outer periphery of the sensor frame penetrating portion 59c of the central shaft 59 and the inner periphery of the sensor frame central hole 53c in the nominal state. This portion also constitutes the displacement restriction mechanism of the present invention.

[0037] The small diameter portion 59d of the central shaft 59 extends downward decreasing its diameter stepwise. The nut 59e is fitted onto the end of the small diameter portion 59d. Fitted onto the outer periphery of the small diameter portion 59d are, from its upper side a washer 61, a rubber washer 63, a sensor base 65, another rubber washer 63, and another washer 61. The washers 61 are made of metal. The rubber washers 63 expand and contract by about 0.5 mm in the sum of two sheets, upper and lower, for a load variation of about 50 kgf in the vertical direction. The rubber washers 63 serve to absorb dimensional difference and strain between the seat rail 11 and the seat connecting portion (a seat bracket 67). The sensor base 65 is a metal plate and comprises a lowermost member of the seat weight measuring apparatus of this embodiment The upper

and lower washers 61, the upper and lower rubber washers 63, and the sensor base 65 are retained between the lower step of the sensor frame penetrating portion 59c of the central shaft 59 and the lower nut 59e.

[0038] The end 65b of the sensor base 65 is fixed to the seat bracket 67 by means of a bolt which is not shown. The seat bracket 67 projects from the chassis.

[0039] The general action of the seat weight measuring apparatus according to the embodiment of Fig. 2 will be summarized.

[0040] The weight of a seat and a passenger loaded on the seat rail 11 are normally transmitted via the sensor plate 57 to the central shaft 59, the rubber washers 63, the sensor base 65, and the seat bracket 67. At this time, the sensor plate 57 gives rise to a deflection roughly proportional to the load which is detected by the strain gauges 57b, to measure the load acting on the sensor plate 57 in the vertical direction. The weight of the passenger is obtained by summing the load measured by each load sensors, front and rear on both sides, and subtracting from the sum the known weights of the seat, the seat rail and the like.

[0041] Meanwhile, when an abnormal force exceeding the measuring range or load limit of the load sensor acts on the seat rail 11, the central shaft nut 59a abuts against the internal surface of the central hole 51a, or otherwise, the central shaft flange 59b or the sensor frame penetrating portion 59c abuts against the sensor frame bottom plate 53b. This action of the displacement restriction mechanism prevents the sensor plate 57 from excessive deformation while securely connecting the seat rail 11 and the seat bracket 67.

[0042] Fig. 3 is a sectional side view of a seat weight measuring apparatus according to another embodiment of the invention.

[0043] In this embodiment, a pedestal 71 is fixed onto the lower surface of the seat rail 11. A central shaft 72 projects downward at the lower central portion of the pedestal 71, penetrating a central hole 77a of a sensor plate 77. Fitted onto the periphery of the central shaft 72 between the pedestal 71 and the sensor plate 77 are a conical spring 73 and a washer 75. Fitted onto the periphery of the central shaft 72 under the sensor plate 77 are a washer 75, a conical spring 73 and a retainer 79, in this order. The lower surface of the retainer 79 is held by a nut 80 which engages with thread 72a of the central shaft.

[0044] The conical spring 73 comprises the member referred to in this specification as the deflection member, and offers a margin of movement between the seat rail 11 and the seat bracket 67. For example, when the sensor plate 77 receives a load variation of 50 kg, the deflection of the sensor plate in the vertical direction is 0.5 mm, and the deflection of the two conical springs 73 in the vertical direction is ±0.5 mm. Thus, the displacement of the seat rail 11 relative to the seat bracket 67 attains to ±1.5 mm. The maximum measuring load for each load sensor is preferably about 150 kg, and the effective measuring load is preferably about 100 kg.

[0045] The both side portions of the sensor plate 77 are fixed onto the sensor base 81 by means of bolts 78. As described above, the central portion of the sensor plate 77 is connected to the pedestal 71 and the central shaft 72 via the conical springs 73.

[0046] The sensor base 81 is a member extending substantially in parallel with the seat rail 11. As described above, the sensor plate 77 is fixed onto the sensor base 81. Ends of the sensor base 81 are fixed to the seat bracket 67. The sensor base 81 is provided with a hole 81a formed therein for receiving the upper portion 79a of the retainer 79.

[0047] In the seat weight measuring apparatus according to this embodiment, a gap of 0.5 mm is kept between the outer periphery of the upper portion 79a of the retainer 79 and the hole 81a of the sensor base 81. Likewise, a gap of 1.5 mm is kept between the upper surface of the flange 79b of the retainer 79 and the lower surface of the sensor base 81. In addition, the outer diameter of the retainer flange 79b is larger than the diameter of the sensor base hole 81a, and the periphery of the flange 79b faces the lower surface of the sensor base 81. When a force exceeding a predetermined value (100 kgf) acts on the seat rail 11, the sensor plate 77 and the conical springs 73 deform and the upper portion 79a or flange 79b of the retainer 79 abuts against the hole 81a or the lower surface of the sensor base 81. In this way, the displacement of the seat rail 11 relative to the seat bracket 67 is restricted.

[0048] In addition, the construction of seat rail 11, and the sensor base 81 can be reversed by providing the displacement restriction mechanism at the seat rail 11.

[0049] The features of this embodiment will be summarized as follows.

(1) The conical springs 73 and the sensor plate 77 are connected in series connection between the seat rail 11 and the seat bracket 67, making the displacement between them caused by the load variation between the rail and the bracket comparatively large. The displacement corresponding to a load variation of 50 kg is set at 0.5 mm, preferably larger than 1 mm, and more preferably about 2 mm. In this way, the gap of the displacement restriction mechanism (the gap between the retainer 79 and the sensor base 81) can be widened, thereby realizing a seat weight measuring apparatus which functions effectively even with component parts with a large dimensional tolerance. In addition, it can be easily installed onto the seat bracket 67 which is a pressed product.

(2) The load sensor is mainly composed of plate-like strain detecting member (sensor plate 77), and the deflection member comprises the conical springs 73 connected in series connection to the sensor plate 77. There is no frame or casing cover-

ing the sensor plate 77. In addition, the most part of the displacement restriction mechanism is installed at the location lower than the sensor base 81. Accordingly, the overall thickness of the seat weight measuring apparatus can be decreased, facilitating the installation between the seat rail and the seat bracket.

[0050] Fig. 4 is a sectional side view showing the construction of a seat weight measuring apparatus according to further another embodiment of the invention.

[0051] From the lower surface of a seat rail 11, two pedestals 91, 91' project at the front and the rear. The both ends of the sensor plate 93 are fixed to the pedestal 91, 91' by means of a bolt 95 or the like.

[0052] A central shaft 97 penetrates a central hole 93a of a sensor plate 93. The central shaft 97 further extends downward to penetrate a hole 103a of a sensor base 103. The upper end of the central shaft comprises a bolt head 97a. Fitted onto the upper outer periphery of the central shaft 97 are washers 99 sandwiching the sensor plate 93. Likewise, fitted onto the lower outer periphery of the central shaft 97 are conical springs 101 sandwiching the sensor base 103. The lower end of the central shaft 97 has a threaded portion with which a nut 105 is engaged.

[0053] A restriction rod 107 projects downward from the lower end of the pedestal 91 to which the rear end portion of the sensor plate 93 is fixed. The rod 107 extend downward penetrating a restricting hole 103a provided at the sensor base 103. Formed at the lower end of the rod 107 is a flange 107a. The longitudinal and lateral displacements of the seat rail 11 and the sensor base 103 are restricted by the abutting of the side surface of the restriction rod 107 against the inner surface of the restricting hole 103a. The upward displacement in which the seat rail 11 is lifted up is restricted by the abutting of the upper surface of the restricting rod flange 107a against the lower surface of the sensor base 103. Likewise, the downward displacement of the seat rail 11 is restricted by the abutting of the head of the bolt 95 under the front pedestal 91 against the upper surface of the sensor base 103.

[0054] The feature of the embodiment of Fig. 4 is as follows.

[0055] The displacement restricting mechanism (the bolt 95, the restriction rod 107, the restricting hole 103a) is arranged offset from the center of the load (the center of the sensor plate 93 and the central shaft 97). This arrangement offers an advantage that the freedom in design is enlarged in which the displacement stroke may be increased or the overall thickness may be decreased. Further, when a horizontal force acts on the sensor plate 93 in the longitudinal or lateral direction, the sensor plate 93 gives rise to a twisting strain which is symmetrical in longitudinal or lateral direction. The resistance variation caused by the twisting strain can be canceled by arranging the strain gauges symmetrically in longitudinal and lateral direction relative to the central axis of the sensor plate 93. As a result, the horizontal force acting on the sensor plate 93 does not influence the overall output of the strain gauge constructed in a bridge circuit, the overall signal of the sensor only indicating the vertical load.

[0056] Figs. 5(A), 5(B) show a construction example of a seat weight measuring apparatus according to a further embodiment of the invention, in which Fig. 5(A) is a plan view of a sensor plate and Fig. 5(B) is a circuit diagram of a strain gauge circuit. The sensor plate 111 is substantially a rectangular plate with rounded corners. In this embodiment, it is made of stainless steel and has a length of 80 mm, a width of 40 mm, and a thickness of 3 mm.

[0057] At the central portion of the sensor plate 111, a central shaft hole 111c having a diameter of 10 mm is provided. At both end portions of the sensor plate 111, bolt holes 111a of which diameter is 8 mm are provided. Attached to portions between the central shaft hole 111c and the both bolt holes 111a are strain gauges 113 in twos or in fours. On both sides of the regions in which strain gauges 113 are attached and of the central shaft hole 111c, slits 111b are formed side by side, along the longitudinal direction of the sensor plate 111. The slits 111b extend in parallel with the longitudinal axis of the sensor plate in the region in which strain gauges 113 are attached, with an interval between each other of 3 mm. At the periphery of the central shaft hole 111c, the silts 111b forms arches having a center in common with the hole. The purpose of these slits is to prevent the decrease in linearity of the sensor output caused by the tension force between the sensor plate fixing bolts, which accompanies the vertical load received by the sensor plate.

[0058] The strain gauges 113 are arranged symmetrically in longitudinal and lateral directions relative to the center of the central shaft bole 111c. The four strain gauges on each sides are arrange in two groups, that is, two compression side strain gauges R-, R-toward the central shaft hole 111c (toward the center) and two tension side strain gauges R+, R+ toward the bolt hole 111a (toward the end). As shown in Fig. 5, the two bridge circuits each consisting of four strain gauges on both sides are connected in parallel connection. In the figure, the numerals 1, 2, 3, 4 in squares indicate terminals 115. By constructing the circuit in which the strain gauges are arranged in the above-described manner, the twisting strain around the central shaft hole 111c is not output from the sensor circuit.

[0059] By arranging four strain gauges on each side as shown in the embodiment, such effects as decreased sensitivity fluctuation are obtained, but principally, arranging two strain gauges on each side is sufficient.

[0060] In order to stabilize the surface strain in the strain gauge region and to decrease the sensitivity fluctuation, the sensor plate can be constructed as follows.

[0061] Figs. 12(A), 12(B) show an example of variation of the sensor plate, in which Fig. 12(A) is a plan view of a sensor plate and Fig. 12(B) is a circuit diagram of the strain gauges.

[0062] In this example, arch-shaped constrictions 111h are provided at both sides of a strain gauge region. The constrictions 111h serve to localize the deformation of the sensor plate, thereby localizing the surface strain of the strain gauge region and stabilizing the sensitivity, The sensor plate 111' used here has dimensions of 30 mm in width and 80 mm in length. In addition, if sensor plate 111' has one end removed and the central portion fixed, a cantilever type sensor plate construction is obtained in which the load is applied on the other end.

[0063] Fig. 13 is a perspective view of another variation example.

[0064] In this example, strain gauges 113 are arranged on both side surfaces 111j of a sensor plate 111". In this figure, only near side is visible but strain gauges are also arranged at far side. The sensor plate 111" of this example is provided with holes 111k at the center of the regions in which the strain gauges 113 are attached. The action of the holes 111k is the same as that of the constrictions in Fig. 12. The dimensions of the sensor plate 111" used in this example are 5 mm in thickness, 20 mm in width, and 80 mm in length.

[0065] Figs. 6(A), 6(B) show the construction of a seat weight measuring apparatus according to a further embodiment of the present invention in which Fig. 6(A) is a general sectional side view and Fig. 6(B) is a plan view of a plate spring.

[0066] From the lower surface of a seat rail 11, two pedestals 121 project at the front and the rear, and both ends of a sensor plate 123 are fixed to the pedestals 121 by means of a bolt 131.

[0067] In this embodiment, a head 125a of a central shaft 125 enters into a hole 11a of a seat rail 11 so that the restriction of the movement in longitudinal and lateral direction can take place between the both. Further, as a deflection member of a seat connecting mechanism, a plate spring 130 is used. The plate spring 130 is, as shown in Fig. 6(B), substantially an elongate plate (material: SSC, thickness: 2 mm, length: 150 mm, width: 30 mm).

[0068] The lower end of the central shaft 125 has a threaded portion with which a nut 129 is engaged.

[0069] The plate spring 130 is provided with a central shaft hole 130c at the central portion and bolt holes 130a at both end portions. The bolt holes 130a are so-called free holes with diameters larger than the bolt diameter, so that dimensional errors of the members can be absorbed. The large oval hole 130b provided at both side portions of the plate spring 130 has the purpose of preventing the interference of a bolt 131 fixing the sensor plate 123 and a restriction rod 133. It has an additional purpose of weakening so that the plate spring flexes sufficiently even at a small fulcrums interval (70 mm in this example, taken between centers of the bolt holes 130a). In addition, the plate spring may have a bellows-like configuration in order to increase the deflection.

[0070] In the seat weight measuring apparatus according to the embodiment of Fig. 6, the displacement restriction between the seat rail 11 and the seat bracket 67 takes place as described below. The displacement in vertical direction is restricted by the abutting of the lower surface of the head of the bolt 131 against the upper surface of the sensor base 135 and abutting of the upper surface of the flange 133a of the restriction rod 133 against the lower surface of the sensor base 135. The displacements in longitudinal and lateral directions are restricted by abutting of the outer periphery of the restriction rod 133 and the inner surface of the hole 135a of the sensor base 135.

[0071] In this embodiment, the sensors are preferably arranged in short bridge. The short bridge means here a sensor plate with very little deflection which has merit of decreased size and cost. Disposed around the outer periphery of the central shaft between the sensor plate 123 and the plate spring 130 is a washer 127. By adjusting the configuration (diameter) of this washer, the sensitivity of the sensor can be adjusted.

[0072] The other feature of the embodiment of Fig. 6 is that the accuracy of the sensor is improved since the deflection member absorbs asymmetrical stress.

[0073] Figs. 7(A), 7(B) show the construction of a seat weight measuring apparatus according to a further embodiment of the present invention in which Fig. 7(A) is a general sectional side view and Fig. 7(B) is a plan view showing a sensor plate and plate spring.

[0074] In this embodiment, a sensor plate 153 is laid on a plate spring 155. The plate spring 155 is a plate made of spring steel with a thickness of 2 mm, a width of 60 mm, and a length of 80 mm. The sensor plate 153 is a plate made of stainless spring steel with a thickness of 0.5 mm, a width of 20 mm, and a length of 80 mm. The sensor plate 153 and the plate spring 155 receive at the central portion the load of seat rail 11 acting via a pedestal 151, and are supported at both end portions by pedestals 160 located on a sensor base 159. Accordingly, the sensor plate 153 and the plate spring 155 are connected in parallel connection and bear the said load on shares. The sensor plate and the plate spring are in the sharing ratio around 1:9-1:19.

[0075] The plate spring 155 is provided with a pair of large lightening holes 155a on both sides. The strain gauges 154 are attached on the upper surface of the sensor plate 153 at locations corresponding to the edges of the holes 155a. This construction has an advantage that a large deflection stroke can be obtained for a short span.

[0076] This embodiment is an example in which the load is shared between the strain sensor and the spring to secure both strength and vertical strain stroke. Generally speaking, a sensor plate constituting a load sen-

sor with a good temperature characteristics has different construction from a plate spring, In this embodiment, the plate spring secures a deflection stroke of over ±1 mm for vertical load. When the stress is concentrated on the strain detecting region in order to raise the sensitivity of the load sensor, the sensor plate deforming together with the spring material is subject to a deterioration because of a large deflection. Against this, the sensor plate is constructed with a thin material, thus dividing the strength and the function, The construction of this embodiment can also be constructed with a decreased thickness enabling the arrangement under the seat rail.

[0077] In the embodiment of Fig. 7, the displacement restriction mechanism is formed between a restricting rod 161 located under the seat rail pedestal 151 and a sensor base hole 159a.

[0078] Fig. 8 is a sectional side view showing a variation example of the seat weight measuring apparatus of Fig. 7. In this embodiment both end portions of a sensor plate 183 and a plate spring 185 are fixed to pedestals 181 on the lower surface of the seat rail 11, and the central portions of the sensor plate 183 and the plate spring 185 are fixed to a pedestal 190 on a sensor base 191. Further, a restriction rod 193 projects downward from an end portion of the sensor plate 183. Such an arrangement with the axes of the restriction rod 193 and the sensor plate 183 arranged offset has an effect that the displacement restriction takes place at a location where the stress is more concentrated.

[0079] Figs. 9(A), 9(B) show a seat weight measuring apparatus according to a further embodiment of the present invention having a cantilever construction, in which Fig. 9(A) is a sectional side view and Fig. 9(B) is a plan view of a plate spring.

[0080] Also in this embodiment, a plate spring 203 and a sensor plate 205 is arranged in parallel. The left end of a spring plate 203 and a sensor plate 205 are fixed onto a sensor base 207 by means of a bolt 209, the sensor base 207 supporting them in a cantilever fashion, The right end portion of the spring plate 203 and the sensor plate 205 are fixed to a pedestal 201 located wider a seat rail 11. A displacement restriction mechanism is formed between a restriction rod 211 under the pedestal 201 and the sensor base 207.

[0081] The use of a cantilever construction as in this embodiment offers an effect that a large displacement can be obtained for a short span.

[0082] Fig. 10 is a sectional side view showing a variation example of the embodiment of Fig. 9. In this embodiment, a sensor plate 227 is arranged under a sensor base 225. This arrangement offers an effect that, by increasing the distance between the sensor plate 227 and a plate spring 223, the sensitivity of the sensor is stabilized since an axis 231 displaces in parallel with an axis 229, thus decreasing the weight detecting error when the seat is inclined in the longitudinal direction. In addition, the distance between a seat rail 11 and a seat bracket 67 can be further decreased.

[0083] Further, in the embodiment of Fig. 10, two rods 231, 233 project downward penetrating the sensor base 225. Either of these rods can be used for the displacement restriction mechanism.

[0084] Fig. 11 is a sectional side view showing a further variation example of the cantilever type seat weight measuring apparatus. In this embodiment, a protrusion 251 projects downward from a seat rail 11 which fits into a hole 253a of a block 253 provided on a sensor base 255. This protrusion 251 and block 253 constitute an independent displacement restriction mechanism.

[0085] A sensor plate 261 is fixed to a pedestal 257 at its left end, and is fixed to the sensor base 255 at its right end.

[0086] The other feature of this embodiment is that it can be constructed in such a manner as to restrict the inclination of the seat rail with the independent displacement restriction mechanism so that only vertical movement is transmitted to the sensor.

[0087] The present invention is by no means limited to the embodiments described above, but various modification can be made according to the basic concepts which are claimed in the claims.

[0088] As can be seen from the foregoing description, the present invention offers the following effects.

[0089] By providing a displacement restriction mechanisms which restrict the relative displacement between the seat and the seat rails within a certain range and bear the excess load, the breaking load of the load sensors can be decreased and a low-cost construction of the apparatus is achieved.

[0090] By setting the deflection stroke of the seat connecting mechanisms and the load sensors at 0.5-8 mm, the deflection corresponding to the load variation within the measuring range or loading range of the load sensors, the seat weight measuring apparatus can be incorporated without problems even at current dimensional precision level of the seat rails or seat brackets. Further, by incorporating a deflection members into the seat connecting mechanisms, the deflection stroke of the seat connecting mechanisms within the measuring range of the load sensors can be amplified. As a result, the dimensional precision and the assembly precision of the members constituting the seat connecting mechanisms and the displacement restriction mechanisms can be alleviated.

[0091] Further, the present invention provides a seat weight measuring mechanism having such advantages as decreased overall thickness of the apparatus and decreased processing cost and assembly cost. In addition, it provides a seat weight measuring mechanism capable of improving the safety against an abnormal force acting on the seat. In further addition, a weight measurement with higher precision and higher linearity can be achieved.

Claims

1. A seat weight measuring apparatus for measuring the weight of a vehicle seat including the weight of a passenger sitting thereon, comprising;

   seat connecting mechanisms arranged between seat fixing portions of a vehicle and a seat;
   load sensors for detecting the seat weight loaded on the seat connecting medianisms; and,
   displacement restriction mechanisms for restricting the displacement of the seat relative to the seat fixing portions mainly caused by the defections of said seat connecting mechanisms and/or load sensors, within a predetermined range.

2. A seat weight measuring apparatus as claimed in claim 1, wherein the deflection strokes of said seat connecting mechanisms and/or load sensors corresponding to load variations within a measuring range or a load bearing range of said load sensors are from 0.5 to 8 mm.

3. An apparatus as claimed in claim 1 or 2, wherein said displacement restriction mechanisms tolerate a displacement ±0.25 to 8 mm with respect to a normal state and withstand a load of at least 300 kg.

4. A seat weight measuring apparatus for measuring the weight of a vehicle seat including the weight of a passenger sitting thereon, comprising

   seat connecting mechanisms including deflection members, arranged between seat fixing portions and a seat of a vehicle;
   load sensors for detecting the seat weight loaded on the seat connecting mechanisms; and,
   displacement restriction mechanisms for restricting the displacement of the seat relative to the seat fixing portions mainly caused by the deflection of said deflection members, within a predetermined range.

5. A seat weight measuring apparatus as claimed in claim 4, wherein;

   said load sensors are provided with detecting members; and,
   said deflection members are members having a spring characteristics such as conical spring or plate spring connected in series connection to said load sensors.

6. A seat weight measuring apparatus as claimed in claim 4, wherein;

   said load sensors are provided with detecting members; and,
   said deflection members also serve as detecting members of said load sensors, or they are members having a spring characteristics such as conical spring or plate spring connected in parallel connection to said load sensors.

7. A seat weight measuring apparatus for measuring the weight of a vehicle seat including the weight of a passenger sitting thereon, comprising;

   seat connecting mechanisms ranged at four corners of the seat between seat connecting mechanisms and seat rails;
   load sensors for detecting the seat weight loaded on the seat connecting mechanisms; and,
   displacement restriction mechanisms for restricting the displacement of the seat rails relative to the seat connecting mechanisms in a predetermined range.

8. A seat weight measuring apparatus for measuring the weight of a vehicle seat including the weight of a passenger sitting thereon, comprising;

   seat connecting mechanisms including deflection members arranged at four corners of the seat between seat connecting mechanisms and seat rails;
   load sensors for detecting the seat weight loaded on the seat connecting mechanisms; and,
   displacement restriction mechanisms for restricting the displacements of the seat rails relative to the seat connecting mechanisms caused mainly by defections of said deflection members and/or load sensors, in a predetermined range.

9. A seat weight measuring apparatus as claimed in claim 7 or 8, wherein;

   anchoring portions fixing anchors of a seat belt (buckle) are connected to said seat rails; and,
   said displacement restriction mechanisms are provided only at the vicinities of the anchoring portions.

10. A seat weight measuring apparatus as claimed in claim 7 or 8, wherein;

    anchoring portions fixing anchors of a seat belt (buckle) are connected to said seat rails; and,
    said displacement restriction mechanisms are

provided at a plurality of locations including the vicinities of the anchoring portions, the displacement restriction mechanisms at the vicinities of the anchoring portions being rigid members capable of withstanding a load of about 2300 kgf.

11. A seat weight measuring apparatus described in any one of claim 1 through 10, wherein said displacement restriction mechanisms are provided at locations offset from the loading axes of said scat connecting mechanisms.

12. A seat weight measuring apparatus described in any one of claim 1 through 11, wherein said displacement restriction mechanisms restrict movements in vertical, longitudinal and lateral directions.

13. A seat weight measuring apparatus for measuring the weight of a vehicle seat including the weight of a passenger sitting thereon, comprising;

seat connecting mechanisms arranged between seat fixing portions of a vehicle and a seat; and,
load seasors for detecting the seat weight loaded on the seat connecting mechanisms, wherein;
each of the load sensor is provided with a strain detecting member having a plurality of strain gauges;
said strain gauges are arranged symmetrically relative to a central axis of said member; and,
said load sensor is constructed in such a manner that a twisting strain around the central axis of said member is not output.

14. A seat weight measuring apparatus for measuring the weight of a vehicle seat including the weight of a passenger sitting thereon, comprising;

seat connecting mechanisms arranged between seat fixing portions of a vehicle and a seat; and,
load sensors for detecting the seat weight loaded on the seat connecting mechanisms, wherein;
each of the load sensor is provided with a strain detecting member having a plurality of strain gauges; and,
constrictions are formed at sides of regions of said member where the strain gauges are attached.

Fig. 1

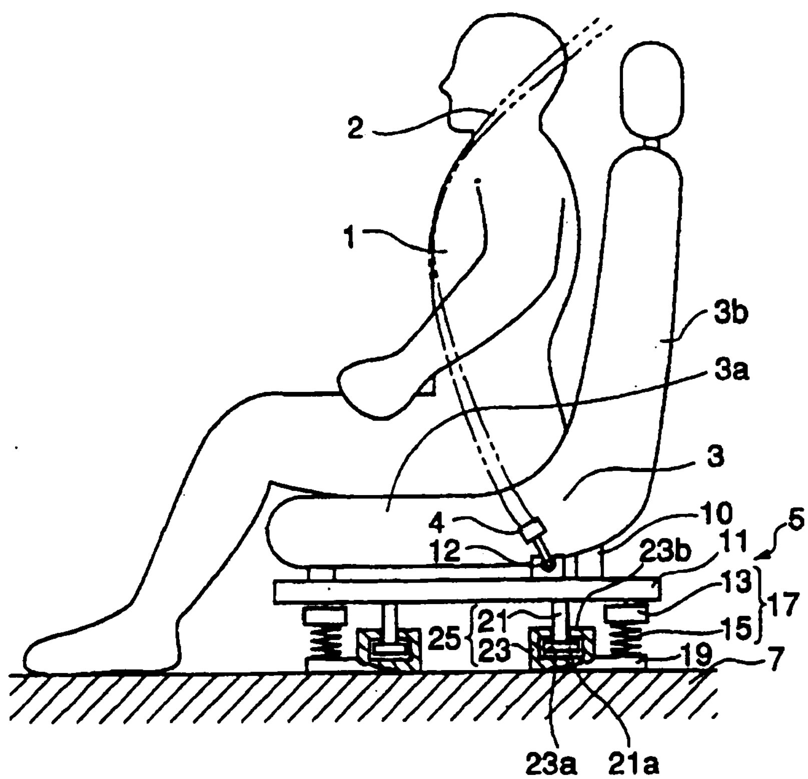
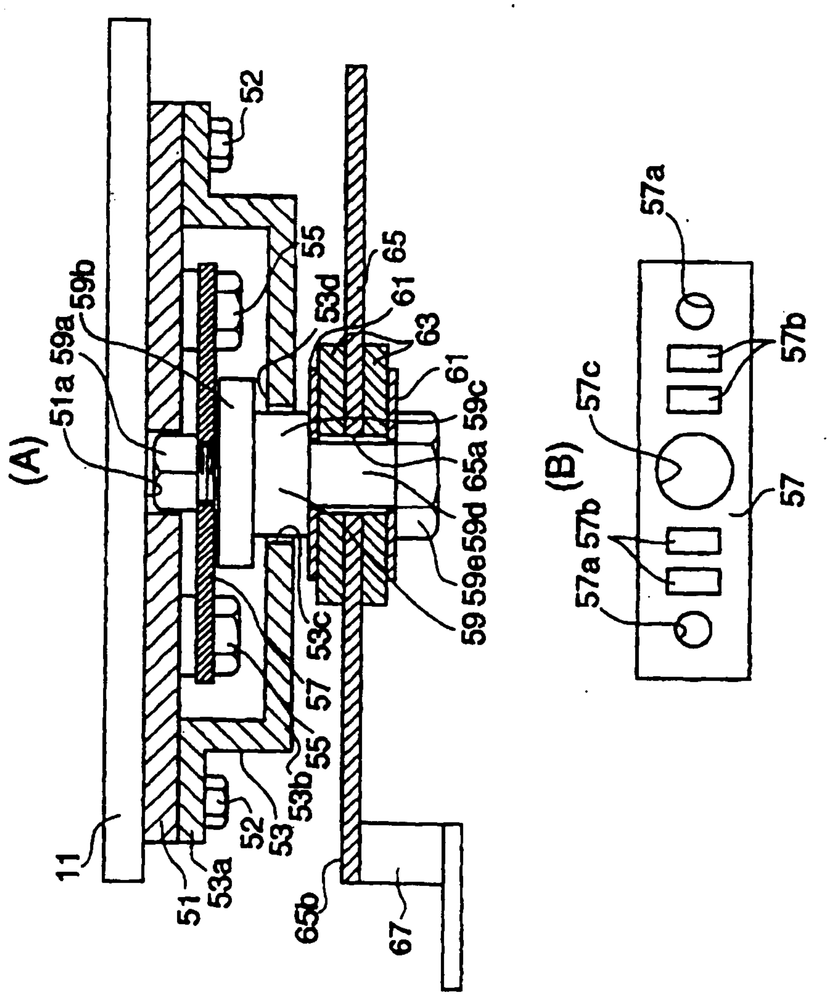


Fig. 2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57a 57b

Fig. 3

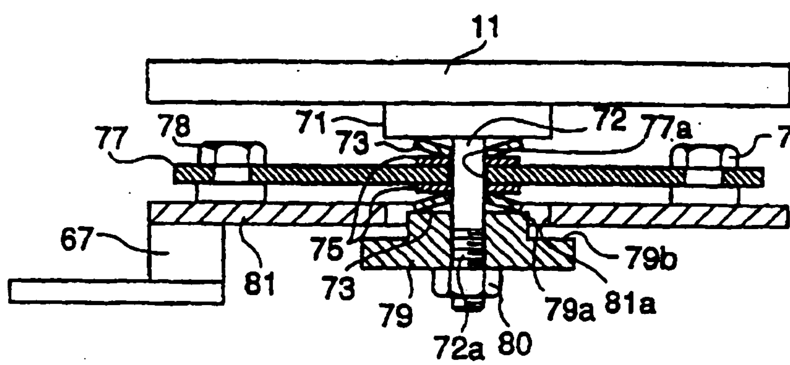
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Fig. 4

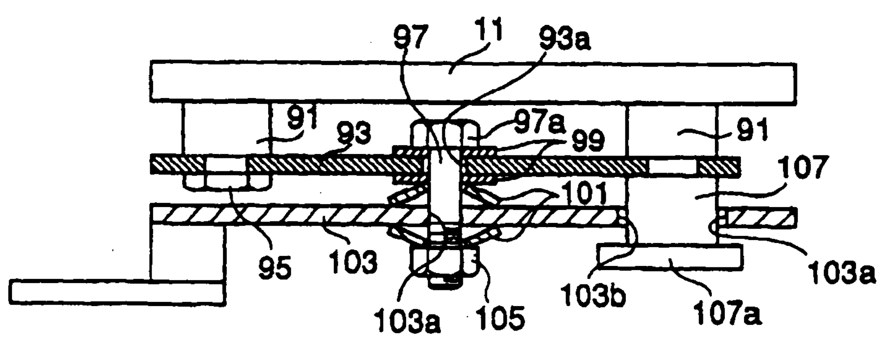
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Fig. 5

(A)

(B)

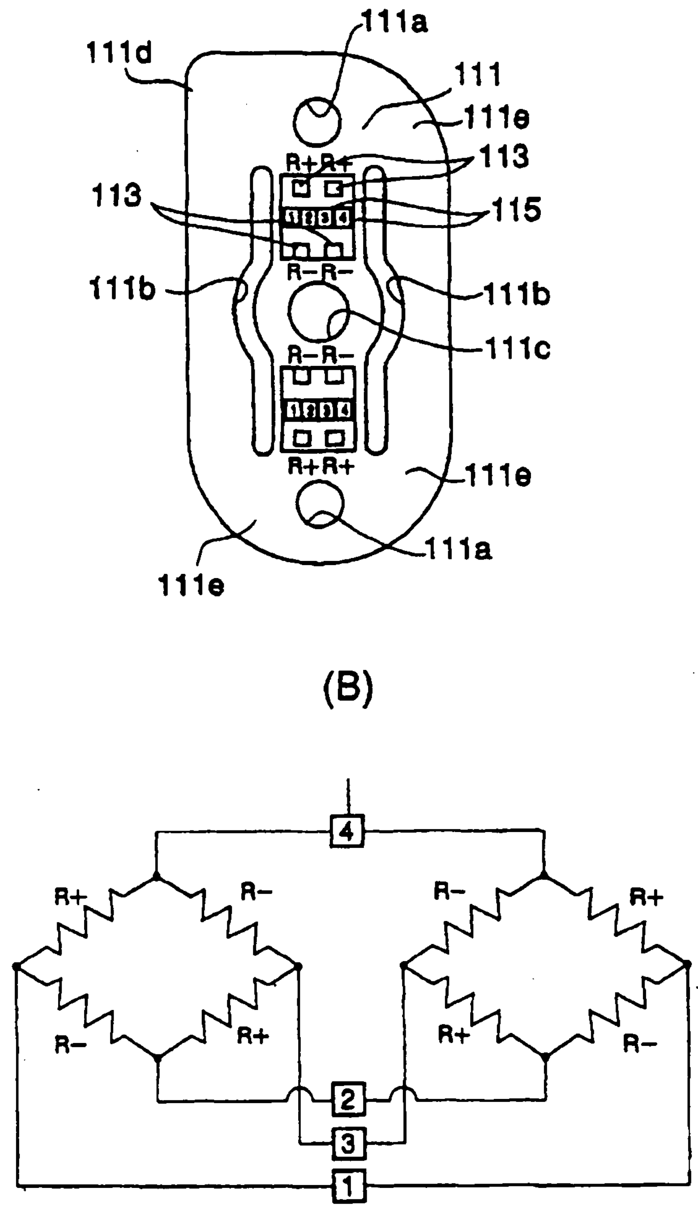
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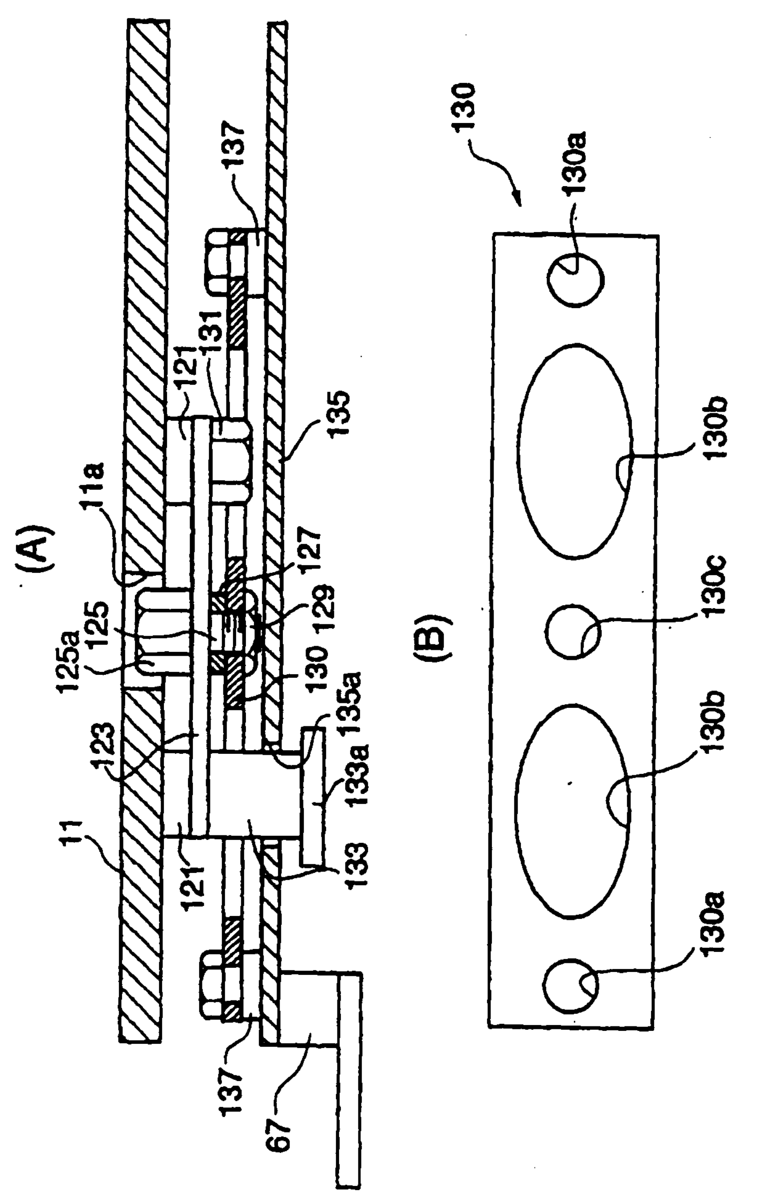
Fig. 6



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123
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67
(B)
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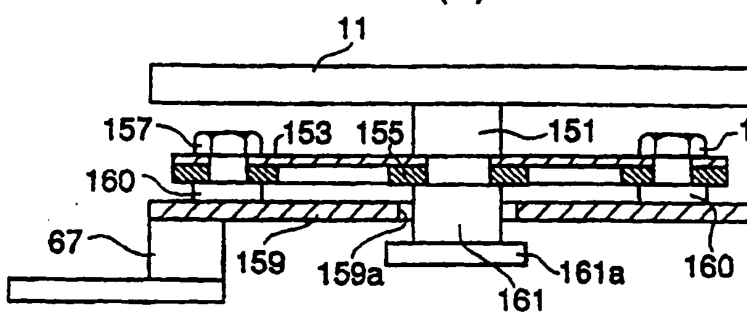
130a
130b
130c

Fig. 7

(A)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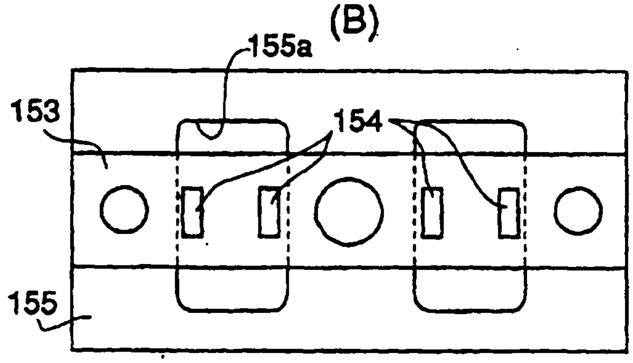
(B)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155

Fig. 8

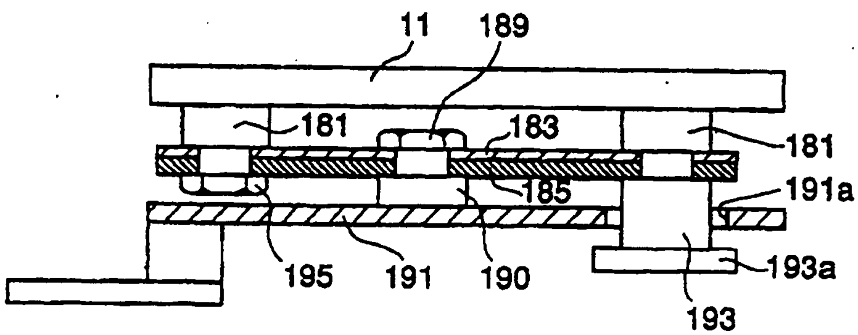


Fig. 9

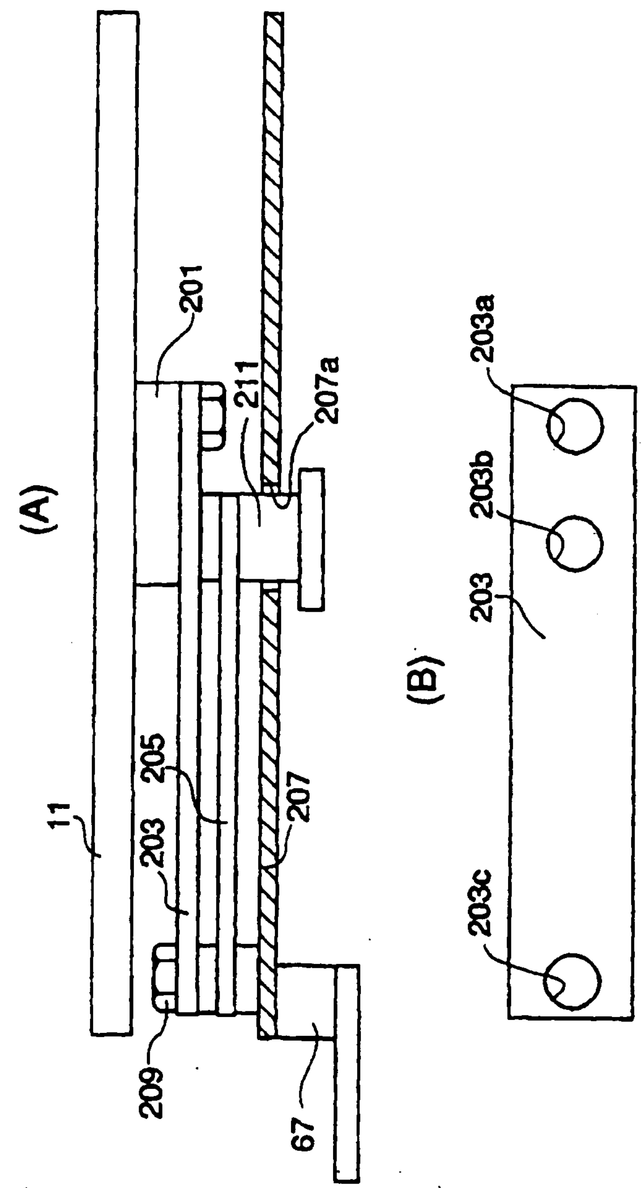


Fig. 10

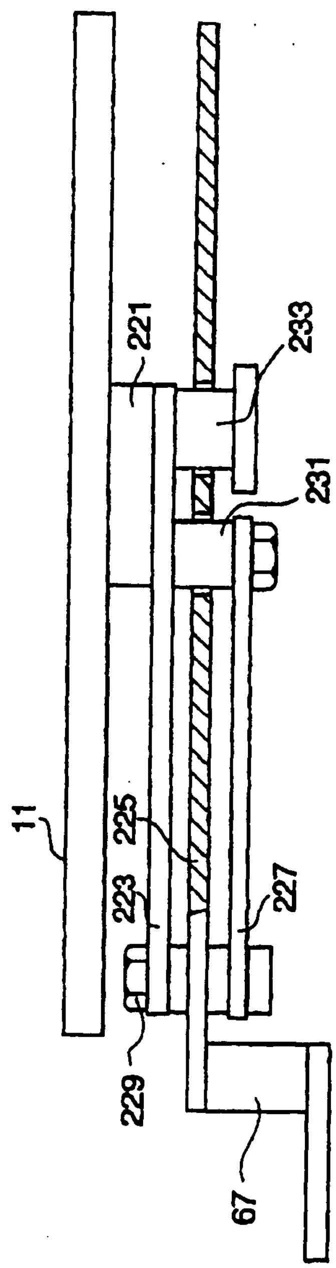


Fig. 11

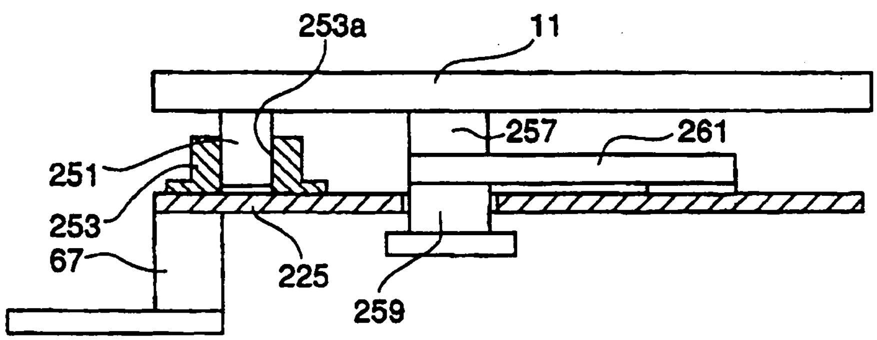
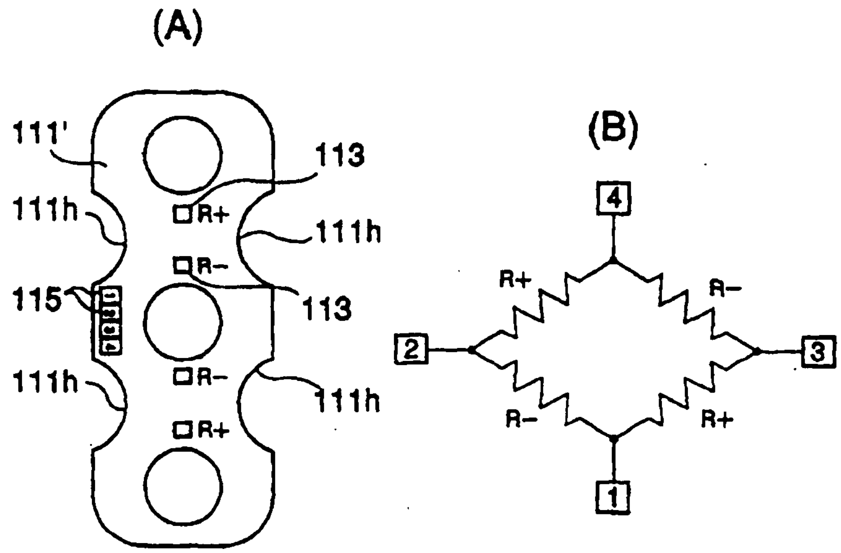


Fig. 12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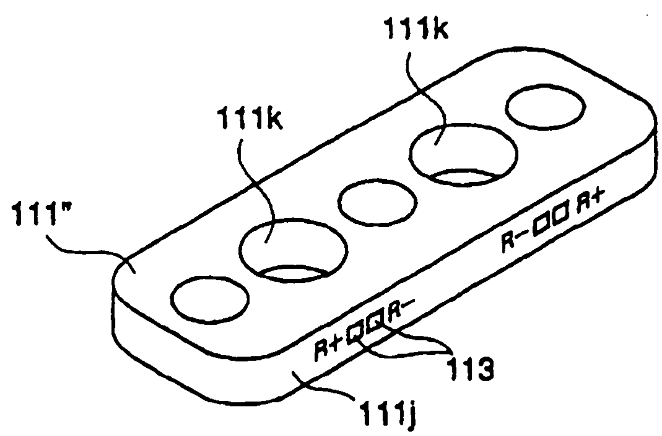
R-
R+
1

Fig. 13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R+
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111j